REGRESSION DISCONTINUITY DESIGN

For Fun and Profit

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In a regression discontinuity design (RDD), units are treated on one side of a threshold or cutoff and not on the other side, and the threshold is determined using a continuous "running" variable. Units very near the cutoff are considered similar except for their treatment status.

WHEN TO USE

Requirement 1

The probability of treatment is determined by a threshold

- It may be the case that all of the units above the threshold are treated and none of those below it are treated. In this case, you have a **sharp RDD**.
- It may be the case that the probability of treatment changes discontinuously at the threshold by less than 1. In this case, you have a **fuzzy RDD**.

Requirement 2

Units sufficiently close to the threshold only vary meaningfully in their probability of receiving treatment.

- There are no jumps at the threshold in characteristics of the units; only the probability of treatment changes discontinuously at the threshold.

WHAT TO DO: THE BASICS

Step 1

Plot data against running variable

- Do you see a jump in the fraction of the sample being treated at the cutoff? Do outcome variables appear to jump? What about other characteristics that should not be affected?

Step 2

Basic RDD

- Say your running variable is x and the cutoff is $\bar{x}$, such that units with $x_i \geq \bar{x}$ are treated (or more likely to be treated), and $x_i < \bar{x}$ are untreated. Let $Z = I(x \geq \bar{x})$ and $w_i = x_i - \bar{x}$.
- Estimate a model of the form $y_{it} = \beta_0 + g(w_i) + Z_i * g(w_i) + \beta_{RDD} Z_i + \epsilon_i$
- The function $g(w_i)$ is a continuous function of the running variable. For example, if g is linear, the model is $y_{it} = \beta_0 + \beta_1(x_i - \bar{x}) + \beta_2 Z_i(x_i - \bar{x}) + \beta_{RDD} Z_i + \epsilon_i$.
- The coefficient β_{RDD} is the change in y at the cutoff. In a sharp RDD, it is also the treatment effect.
- If the probability of treatment increases by less than one at the cutoff, you can scale the observed change at the cutoff by that probability to arrive at the treatment effect.

INFERENCE

- Use robust standard errors, but do not cluster on the running variable if it is discrete (Kolesár and Rothe 2018)!

HOW THE PROS DO IT

- See Cattaneo, Idrobo, and Titiunik 2020 for ways to optimally select the bandwidth.
- Verify results are not sensitive to bandwidth or choice of $g(w)$.
- If there are characteristics that should not be changed by the treatment (e.g. pre-treatment demographics), try putting them on the left hand side and show there is no change at the cutoff.
- Controlling for unit characteristics may increase precision even if they do not change at the cutoff.
- Using polynomials higher than order 2 for $g(w)$ is generally frowned upon (Gelman and Imbens 2019). Try a local linear regression or lower order polynomial instead!

RATING

Difficulty	●●●○○
Fun	●●●●●
Validity	●●●●○

MAKE IT SIZZLE

- Do you observe periods before and after the cutoff rule was in place? If so, you may be able to estimate the elusive "diff-in-diff-RD" model!
- Do this estimating β_{RDD} using data from prior to when the cutoff was instituted, and then again after the cutoff was instituted.

SOURCES

References

- Cattaneo, Matias, Nicolas Idrobo, and Rocio Titiunik (2020). “A Practical Introduction to Regression Discontinuity Designs: Foundations”. In: Cambridge Elements: Quantitative and Computational Methods for Social Science.
- Gelman, Andrew and Guido Imbens (2019). “Why High-Order Polynomials Should Not Be Used in Regression Discontinuity Designs”. In: Journal of Business and Economic Statistics.
- Kolesár, Michal and Christoph Rothe (2018). “Inference in Regression Discontinuity Designs with a Discrete Running Variable”. In: American Economic Review 108.8.